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Studies of Planetary Physics

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Description of Research and Results:

A. Radio

A major objective of this work has been the study of Jupiter's radio emission at wave lengths longer than used heretofore. A description of our interferometer and other general remarks are contained in our Interim Report of Nov. 24, 1964.

The observations from July through December 1964 are now being studied, and several results have been obtained. Table I summarizes the data for the several frequency channels used. The "effective observing time" means the total time we observed and (1) observing conditions were satisfactory, (2) the equipment was working correctly and the limiting flux sensitivity was $3x10^{-21}$ w/m^2cps or better, and (3) Jupiter was above the "radio horizon", whose zenith distance, Z_H, is computed from the simple relation sec $Z_H = f/f_0$. The critical frequency, f_0, was obtained from the ionosounder at Ft. Belvoir, Va. One should remark that "satisfactory observing conditions" exclude the 20% or so of the time during which an unexplained terrestrial noise source is observed (see Interim Report of Nov. 24).

Table I also contains the number of Jupiter events recorded, and their total duration. Identification is based on two criteria: (1) a recognizable "fringe" pattern* must be produced, implying phase coherence at the two antennae of the interferometer, and the period of this pattern should have an average value implied by the diurnal motion of Jupiter; and (2) the observer must have been attending the receivers and have domonstrated that the event was not a radio station or other recognized interference. In practice, ionospheric effects render the fringe pattern complex, and hard to interpret. Further, an average fringe period is not well determined unless the event lasts sufficiently long - about an hour. Therefore events are divided into two classes: (A) in which the criteria are reasonably well satisfied, and (B) in which agreement is less certain. Class B includes some events that are too short to complete an entire fringe, but are apparently Jovian, and also some longer events which may or may not be Jovian, although the observer could find no other explanation. Identification is made separately for each channel.

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* Our strip charts record power x cos (phase angle), giving waves analogous to optical "fringe".

The occurrence probability is the ratio of the total duration of emission from Jupiter to the effective observing time. It is most interesting to note that storms occur more often at 5 mc/s than elsewhere, although even this maximum is far below typical figures for 14-20 mc/s radiation. No definite radiation was identified at 3.5 mc/s, although observations should have been possible. The validity of this rather peculiar frequency distribution depends, of course, upon the flux calibration of the antennae. However, to remove the dip in number of storms occurring at 6-7 mc/s, the flux would have to be underestimated by a factor of five, or more, relative to 4.7-5.2 mc/s. This seems unlikely, but more work needs to be done.

The longitude dependence is shown in fig 1. This histogram shows the number of 50-minute intervals during which radiation from Jupiter was received on one or more frequencies. The surprising feature is the relative durth of radiation near region A (System III Longitude = 190°-280°), for this region is by far the most active above 15 mc/s. In other words, the longitude profile for low frequencies appears to be complimentary to profile for higher frequencies.

Concerning the satellites, the only correlation turned up so far is a tendency for emission to be more likely when Io is west of the planet (i.e. the angle from superior conjunction is greater than 180°).

Some work remains on completing the analysis of this year's observations. Also improvements are being made in the equipment for the next apparition.

B. Spectroscopy

Since 1962 forty-one exposures of Jupiter have been obtained with the high dispersion spectrograph on the 20-inch refractor at the Van Vleck Observatory. Sixteen of these were taken using a dove prism to rotate the image of the planet so that its equator lies along the spectrograph slit. Mr. Howard Meyer has studied these plates attempting to measure the controversial "anomalous line tilt" (Spinrad Ap.J. 136, 311, 1962). Due to the rotation of the planet both reflected Fraunhoffer lines and the absorption lines at NH_3 appear to slant; however the tilt of the NH_3 appears much less than one-half the Fraunhoffer line tilt, which was expected. Since 1962 not all observers have confirmed the effect. Mr. Meyer's work has shown that our plates usually show the "anomalous" effect. We have not found a satisfactory explanation in terms of instrumental defects, and the effect may be real. However, we suspect that some sort of "seeing" phenomenon may be at play. We are continuing to explore these possibilities.

TABLE I

Frequency Channel.	Effective Observing Time	EVENTS Iden. Number	Class A Total Time	Iden. Number	Class A and B Total Time	Occurance Probability A	A+B
3.5 mc/s	95 hrs.	none		1?	0.5 hr.	0	0.5%
4.1	151	2	1.7 hrs.	7	4.2	1.1%	2.8
4.7	202	4	5.9	10	10.3	2.9	5.1
5.2	161	3	6.5	10	8.0	4.0	5.1
5.5	415	5	4.2	14	10.4	1.0	2.5
6.5	280	4*	4.0*	11*	6.3*	0.4 1.6*	1.0 2.3*
7.3	168	5*	6.0*	9*	8.8*	0.4* 3.5*	1.4 5.2*

*note: The limiting flux at 6.5 and 7.3 mc/s is usually 1 x 10^{-21} w/m^2cps or better. Therefore, the summary of events includes events weaker than 3 x 10^{-21}, the limit for lower frequencies. The occurance probability is computed, omitting events weaker than 3 x 10^{-21} w/m^2cps and then including these events (*).

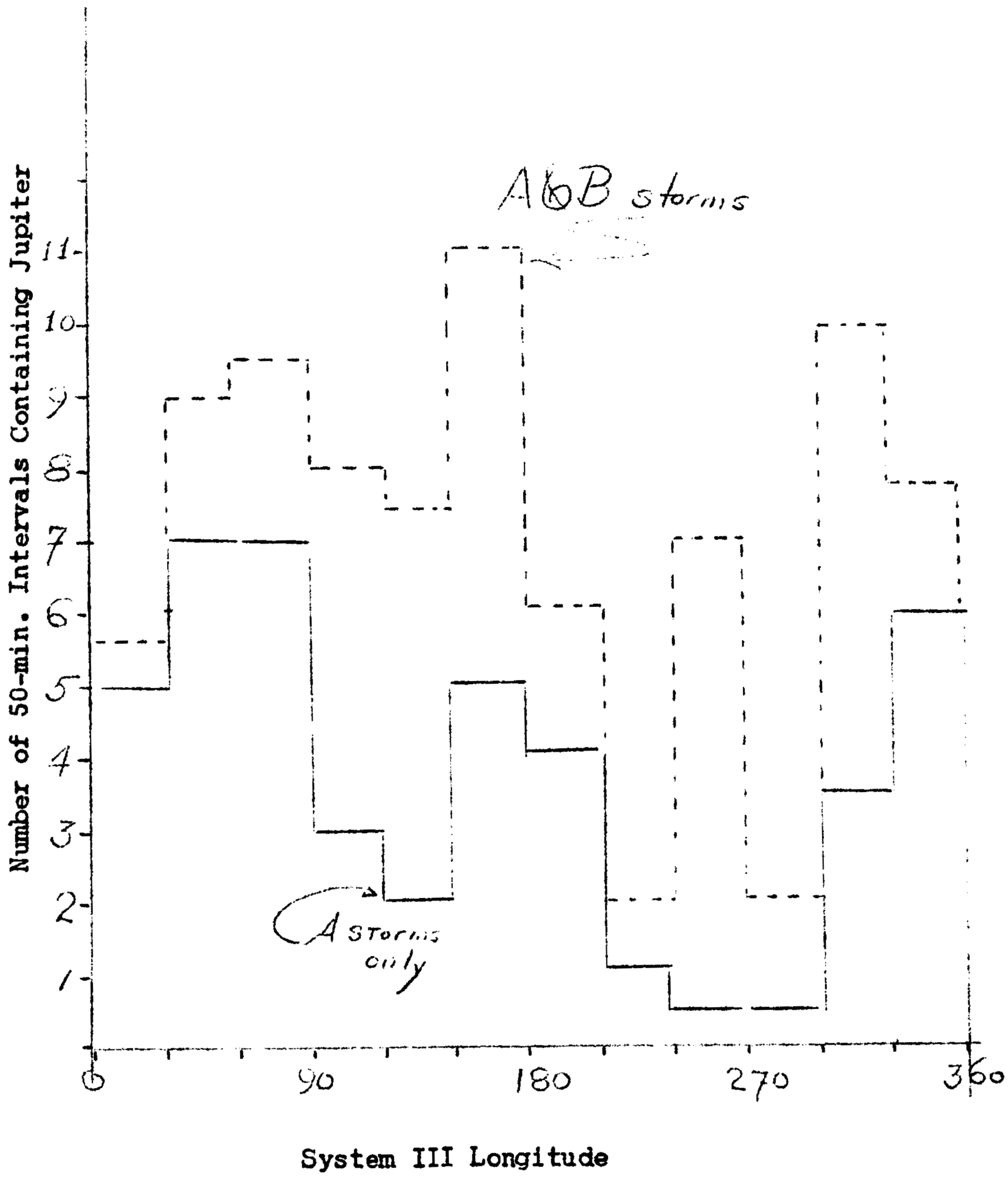

fig. 1 Longitude profile of Low frequency Jovian Radiation